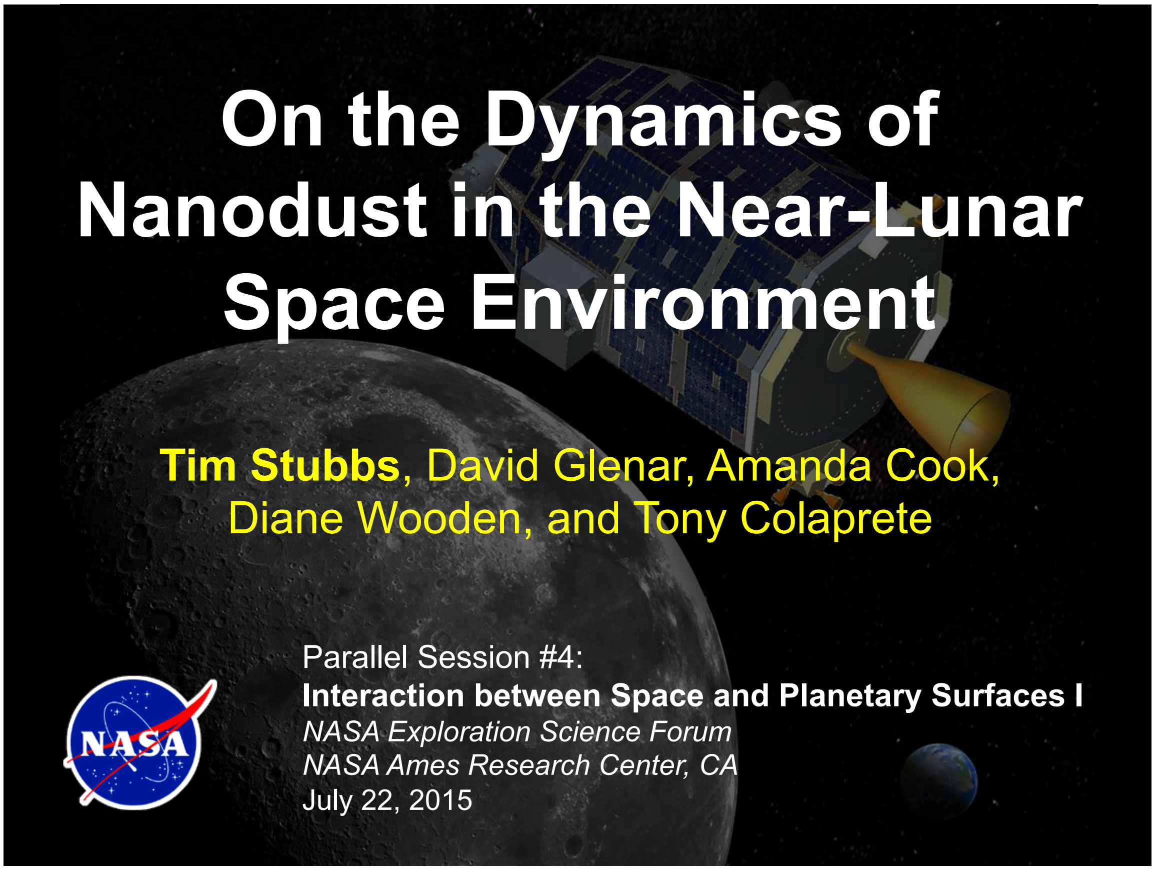

On the Dynamics of Nanodust in the Near-Lunar Space Environment

Tim Stubbs, David Glenar, Amanda Cook, Diane Wooden, and Tony Colaprete

Parallel Session #4:
Interaction between Space and Planetary Surfaces I
NASA Exploration Science Forum
NASA Ames Research Center, CA
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Motivations and Objectives

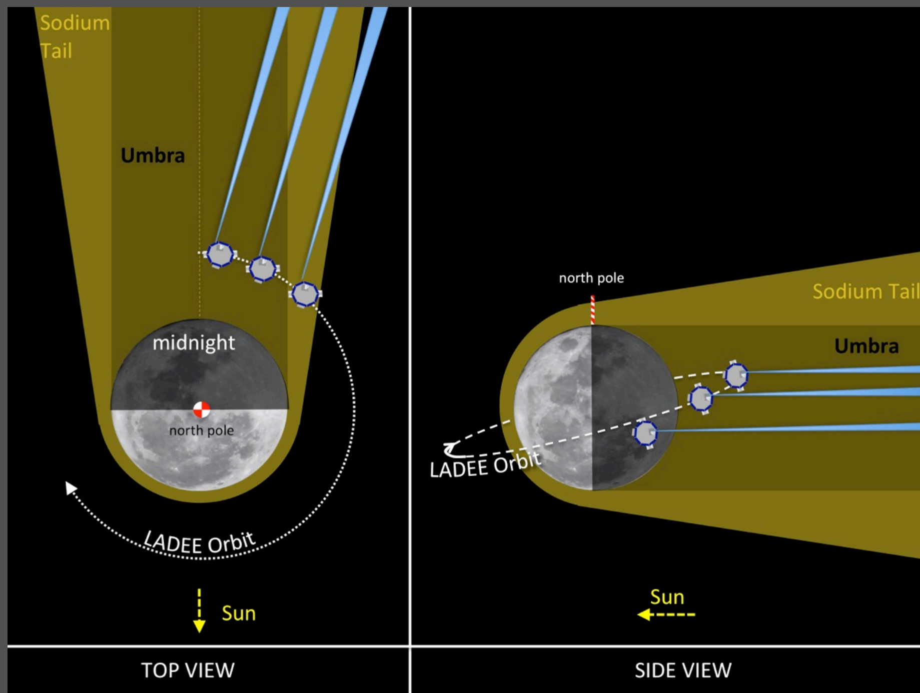
A transient nanodust population was inferred from LADEE/UVS observations when viewing anti-sunward from above the nightside of the Moon – a serendipitous discovery!

Best example occurred several hours after the peak of the narrow but intense Quadrantid meteoroid stream.

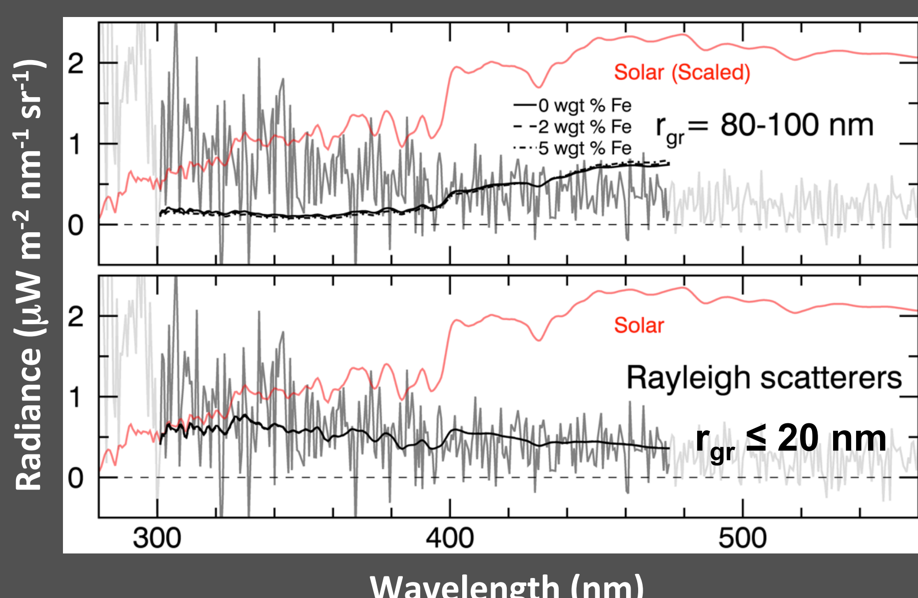
What is the source of this nanodust?

How did it get there?

Summary of UVS Dust Observations



Summary of UVS Dust Observations

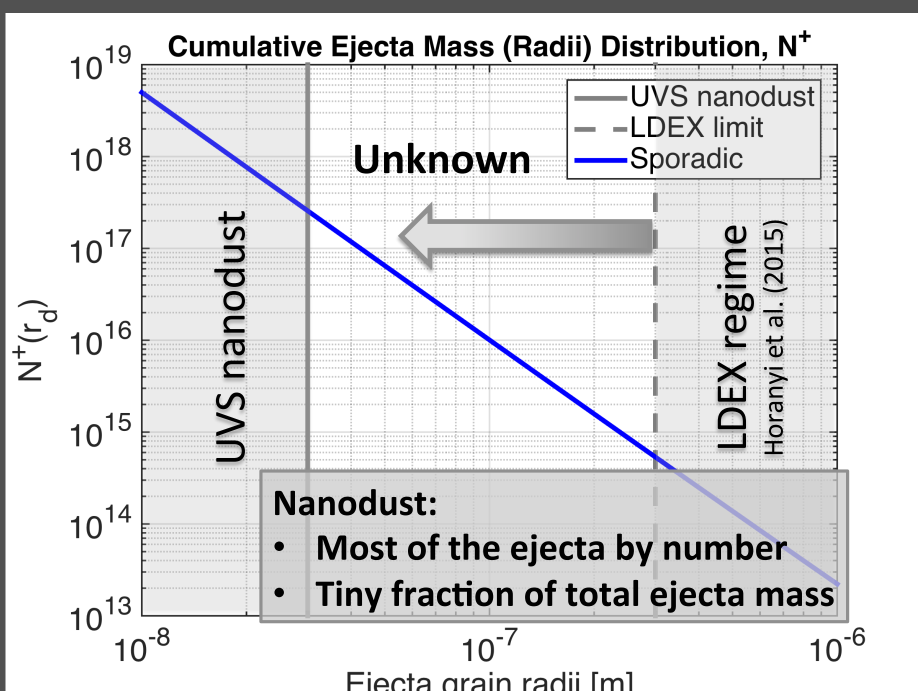


UVS nanodust column concentrations > ~10^{11} m^{-2}

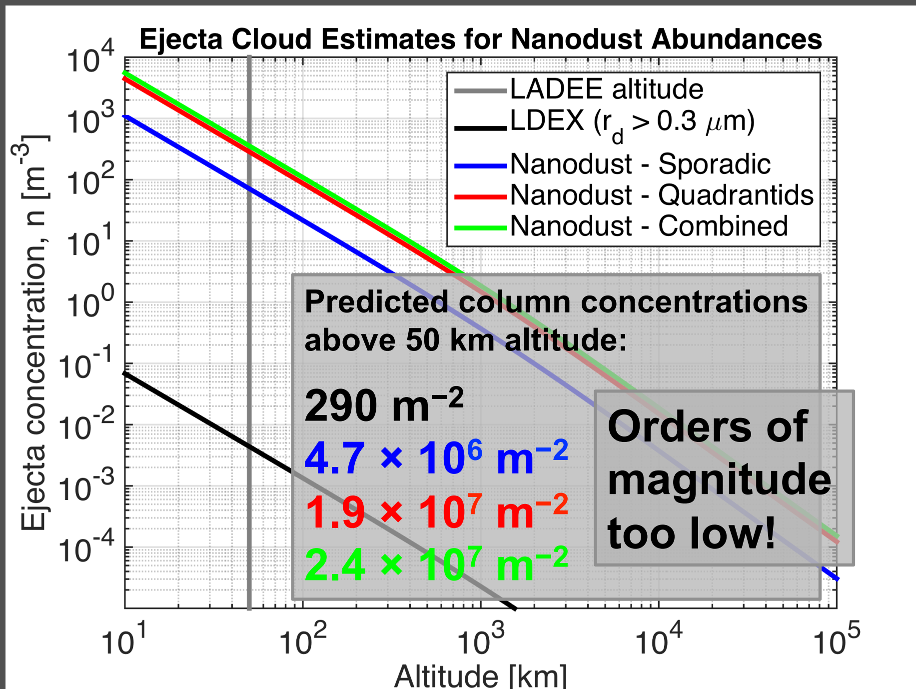
What is the source of this nanodust?

Could it be part of the impact-generated ejecta cloud?

Krivov et al. (2003) Ejecta Cloud Predictions



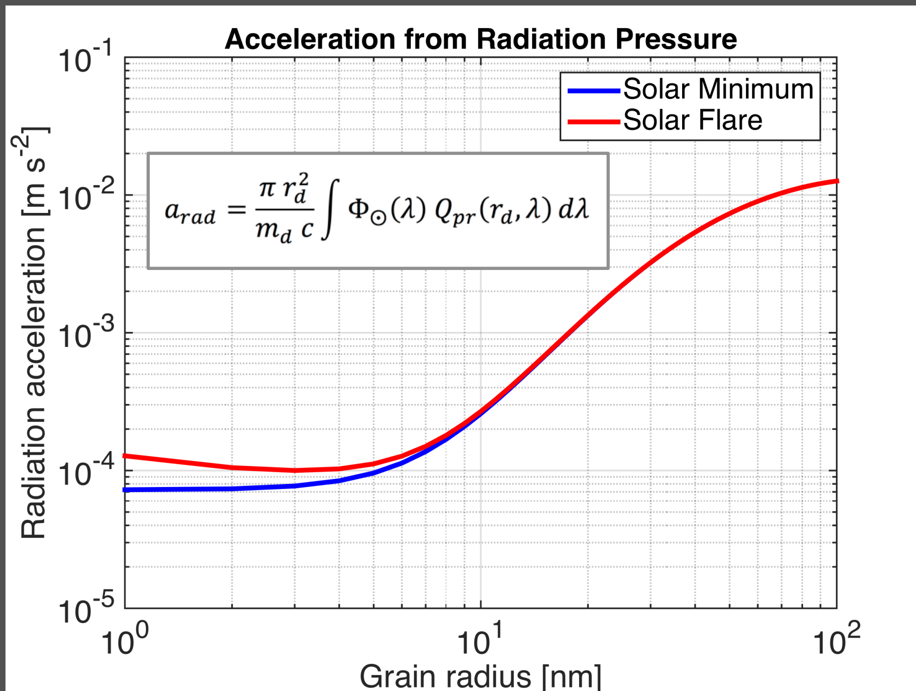
Krivov et al. (2003) Ejecta Cloud Predictions



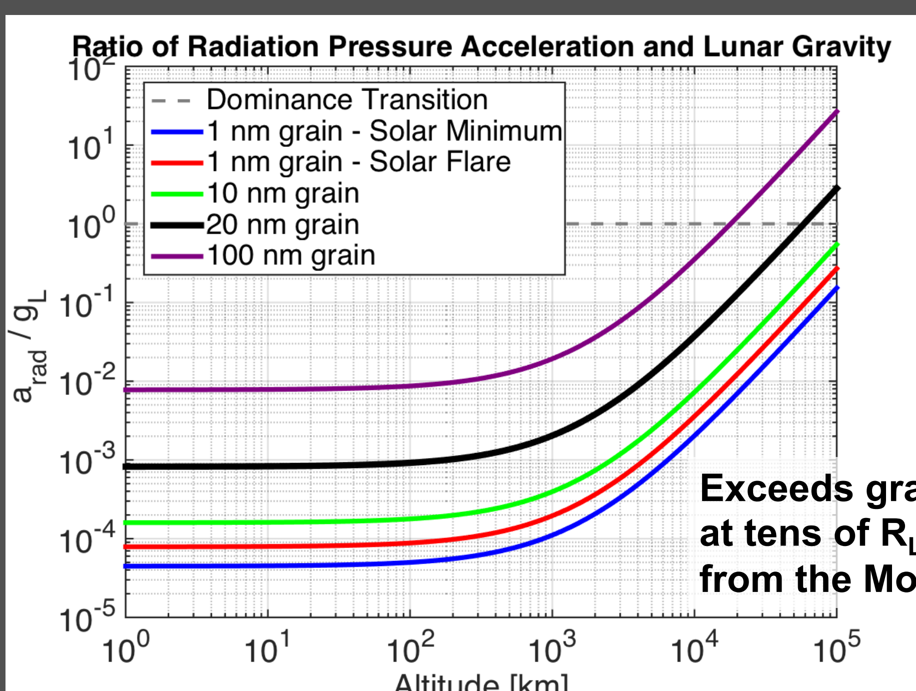
How did it get there?

What forces determine the trajectories of nanodust particles in the near-lunar space environment?

Radiation Pressure on Nanodust



Radiation Pressure on Nanodust



Exceeds gravity at tens of R_L from the Moon

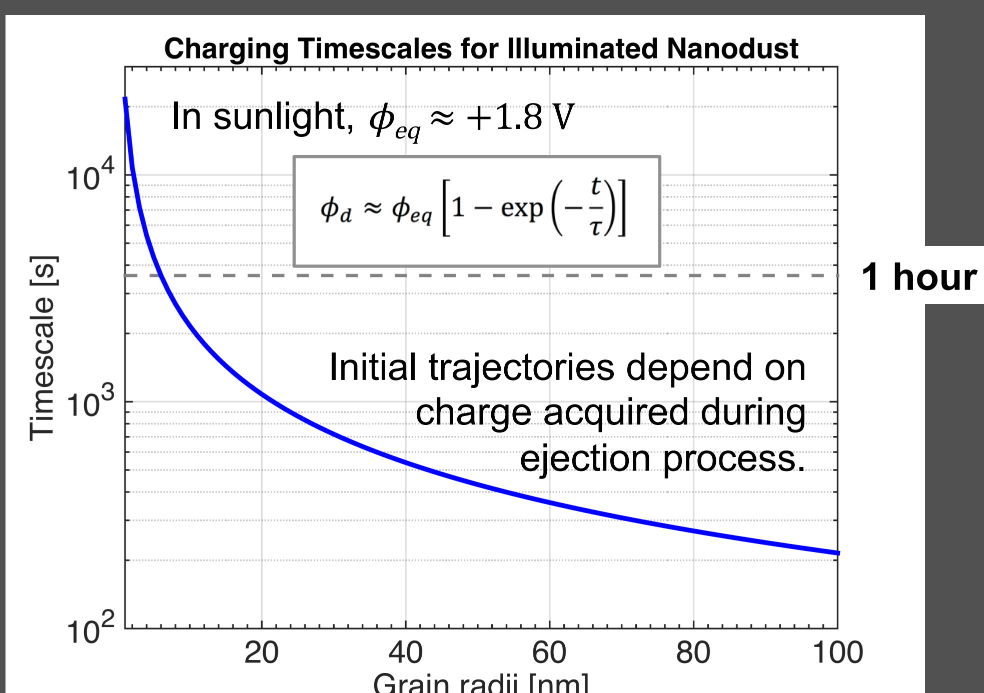
Lorentz Force on Nanodust

$$\mathbf{a}_L = \frac{q_d}{m_d}(\mathbf{E}_{sw} + \mathbf{v}_d \times \mathbf{B}_{IMF})$$

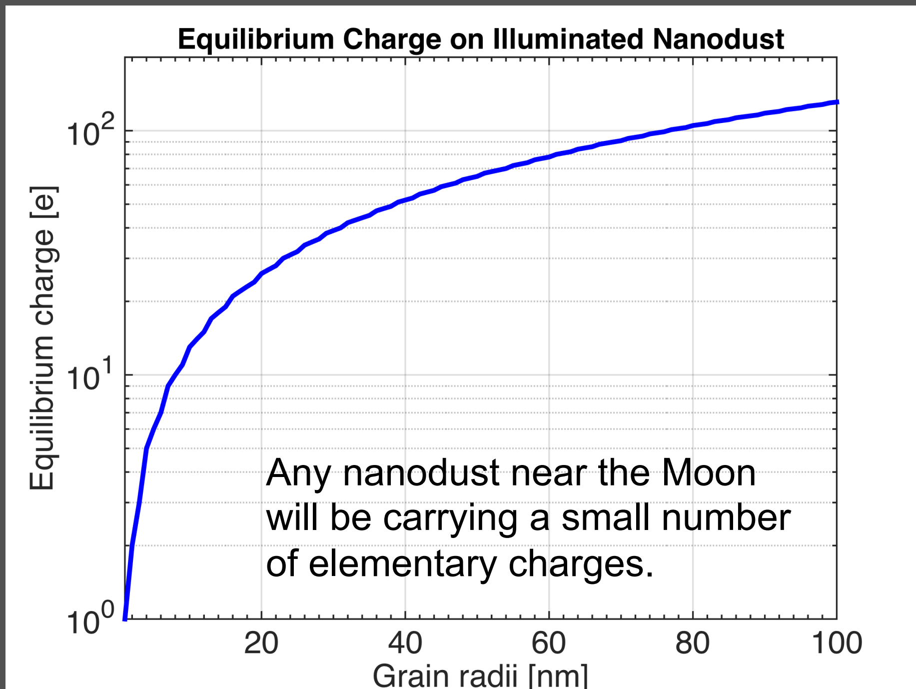
$$\mathbf{a}_L = \frac{3\epsilon_0 \phi_d}{\rho\, r_d^2}[(\mathbf{v}_d - \mathbf{v}_{sw}) \times \mathbf{B}_{IMF}]$$

No charge = No Lorentz force

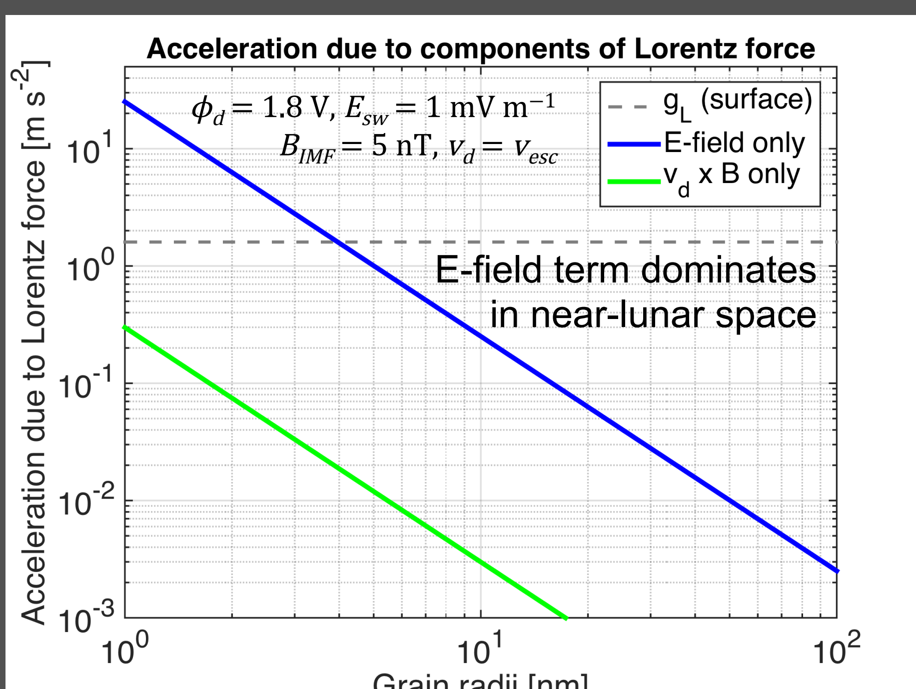
Lorentz Force on Nanodust



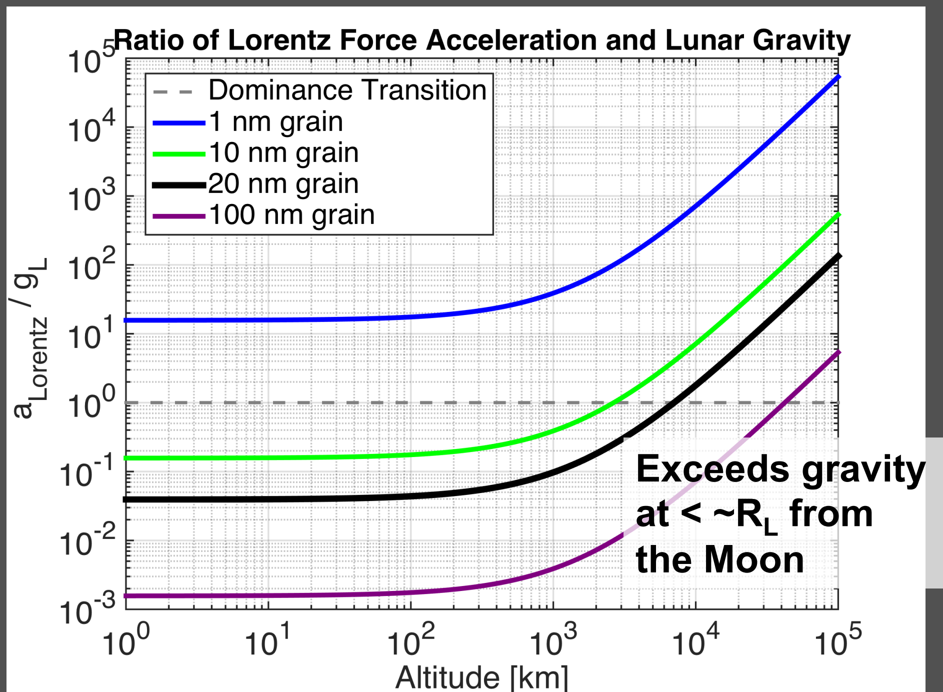
Lorentz Force on Nanodust



Lorentz Force on Nanodust

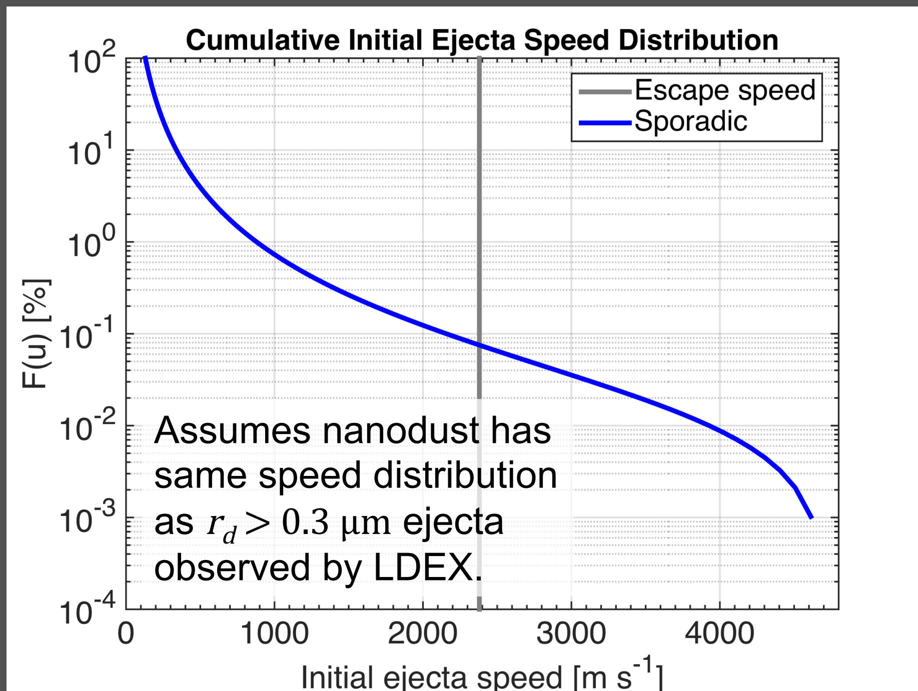


Lorentz Force on Nanodust

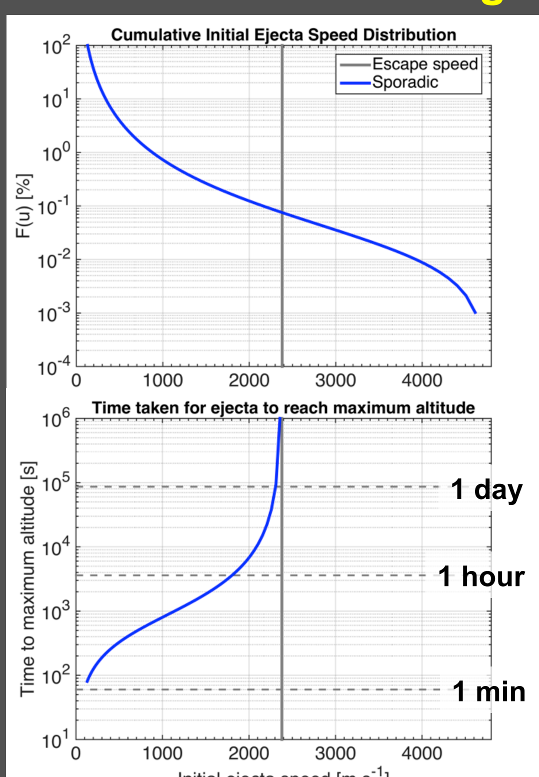


How would these forces effect nanodust dynamics?

Ejection Velocity Distribution of Nanodust



Time-of-flight of Nanodust



Consider 1-D nanodust time-of-flight for illustration.

Dwell time is indicative of contribution to line-of-sight concentration.

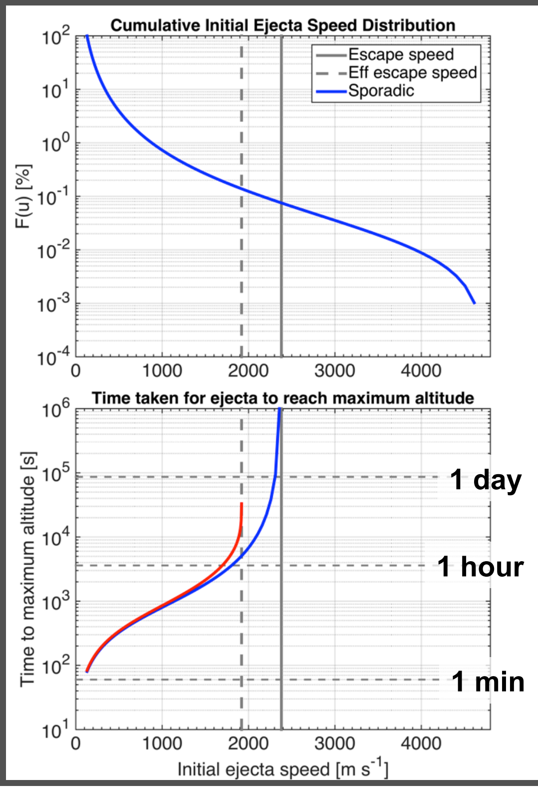
~0.2% getting to ~10^3 km altitudes for ~hours.

Lorentz force!

Include effects of:
$E_{sw} = 1$ mV m^{-1} on grain with $r_d = 20$ nm and $\phi_d = 1.8$ V acting AGAINST gravity.

Similar to the situation on the dawnside post-QUA.

Ejection Velocity Distribution of Nanodust



Include effects of: $E_{sw} = 1\ \mathrm{mV\ m^{-1}}$ on grain with $r_d = 20\ \mathrm{nm}$ and $\phi_d = 1.8\ \mathrm{V}$ acting AGAINST gravity.

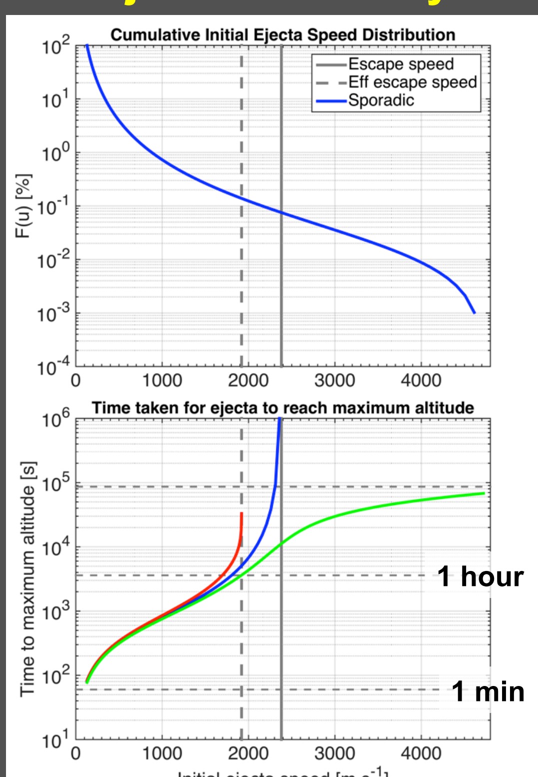
Similar to the situation on the duskside post-QUA.

Reduces the effective escape velocity to $\approx 1.9\ \mathrm{km\ s^{-1}}$.

Factor of ≈ 2 increase in escaping ejecta.

Would act to increase nanodust line-of-sight column abundances.

Ejection Velocity Distribution of Nanodust



Opposite case:

Lorentz force acting WITH gravity.

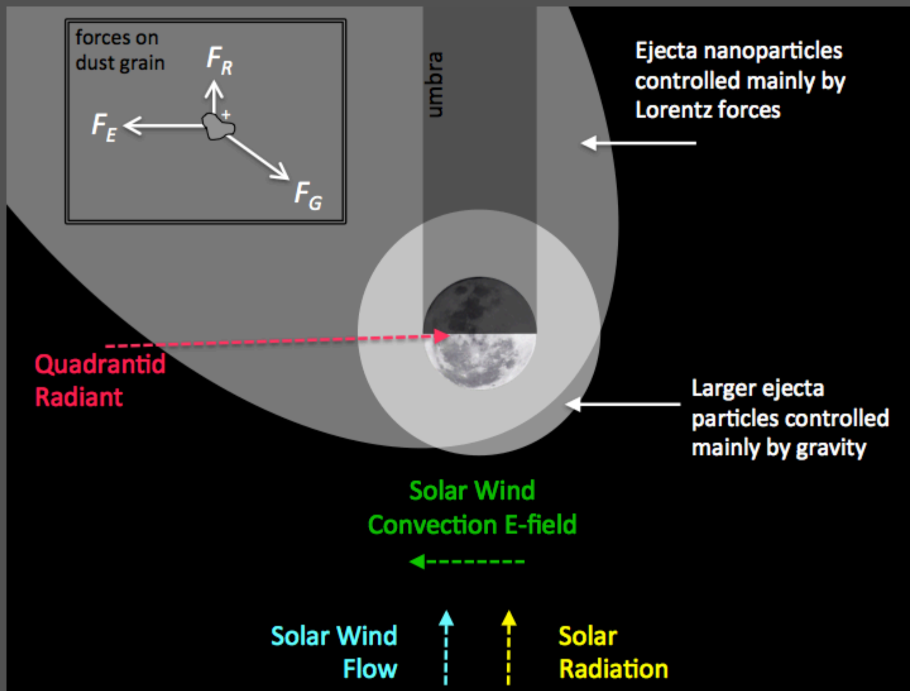
Similar to the situation on the duskside post-QUA.

No nanodust can escape – it's all effectively trapped.

Times-of-flight reduced to <~day.

Could play a role in the post-QUA midnight-to-dusk decrease in UVS nanodust column abundances.

Possible post-QUA nanodust cloud configuration?



Summary and Conclusions

UVS observations of nanodust are difficult to explain!

Estimates from *Krivov et al.* (2003) impact ejecta model, applied using parameters from LDEX regime, fall short by orders-of-magnitude.

Any nanodust in near-lunar space would be slow to charge – initial trajectories would depend on charge acquired during ejection process.

Radiation pressure has a minor effect.

Lorentz force (E-field component) can dominate the motion of nanodust ejected close the escape velocity.

Lorentz force could perhaps act to an increase in line-of-sight abundances and form asymmetries in the distribution of nanodust surrounding the Moon.